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THE MOLDS OF CIGARS AND THEIR PREVENTION.

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INTRODUCTION.

In 1901 a number of complaints were received from eastern cigar manufacturers to the effect that considerable losses were being sustained through the appearance of moldy growths on the finished products. These growths in some cases appeared within about three days after the manufacture and the boxing of the cigars, thus frequently being noticed before they left the factory. In some instances, however, they did not appear until after considerable periods of time. If the mold was detected before the cigars left the factory, the only recourse was to wipe off the growth by hand, a rather expensive process. Perhaps equally objectionable results followed when the mold was not discovered until the cigars were in the hands of the buyers. In either case very considerable loss was likely to result.

The writer was asked to study the problem and, if practicable, to work out feasible means by which the trouble could be remedied. Several factories in which this trouble appeared were visited, managers were consulted, and materials for further work were obtained.

FACTORY CONDITIONS.

In order to get light on the conditions to be dealt with, the processes involved in making the brands of cigars most liable to mold were observed in the factories. In the case of one factory more difficulty was experienced with Sumatra wrappers than with other sorts, and the trouble was believed to be worse in rainy seasons than at other times. The mold usually appeared most abundantly on the "head," or closed end of the cigar, less frequently on the veins or

Note.—This paper discusses the losses due to the development of molds on cigars, outlines the studies directed toward the prevention of them, and presents practical directions for the use of an effective remedy. The molds were found to be introduced principally through the gum-tragacanth paste used to fasten the small flap at the head of the cigar. The sterilization of the paste by using a nearly saturated solution of boric acid instead of water in mixing it has proved so successful that it has become a routine process in the factory in cooperation with which the investigations were conducted.

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other elevated portions of the wrapper, but in some cases the entire surface was more or less involved.

The wrapper leaf is usually prepared for use the day before it is actually used in manufacture. It is first brought into the necessary moist condition, or gotten into "case," by dipping into water. The leaves are bound into small bundles in which the bases of the leaves are tied together. These bundles, or "hands," are grasped by their bases and carried down into and through the "casing" liquid with a scooping motion, so performed as to drag the bundle of leaves with the bases ahead, the blades of the leaves being pulled through the liquid. After this quick dip, the bundles are shaken and set upright on a draining board to permit the surplus liquid to drain away. The pile, loosely packed together, is then covered with a moist cloth and allowed to stand until the droplets of water clinging to the surface of the leaves have been absorbed. In a few hours the leaf becomes soft and pliable without giving the impression of being wet. The ribs are then pulled out and the broad leaf blades are worked up as their size, shape, and quality may determine. The freshly made cigars are then sorted according to colors and boxed immediately, or sometimes held in bundles, to be packed later.

In this condition each cigar is round, and the prescribed number of cigars when placed in the box overfill it, so that the cover must be brought into place by the use of pressure. Here the moist cigars yield to each other and take on such flattened sides and angles as may be required to get the box closed. Sometimes the lids of the boxes are considerably bent by the pressure of the fresh cigars, and the boxes are then placed for a day in large presses before they are nailed up. In warm weather the mold sometimes appears while the boxed cigars are in the presses; that is, within 48 hours after they are made, but more frequently within a week or two after making. When warm, humid weather conditions prevail it is not rare for molds to appear while the cigars are in transit or in storage. Since heat and moisture are necessary conditions for mold development, it follows that little trouble is experienced in the winter months but much during the hot summer months.

A number of attempts had been made by the factory managers to remove this source of loss. Small quantities of vinegar in the water (1 pint in 4 or 5 gallons) used for casing wrapper leaf were found to aggravate the trouble. When the leaf was cased in vinegar at full strength the molds were suppressed, but the luster of the leaf was thought to be impaired. Casing in alcoholic solutions was found to be helpful, but too expensive. Small quantities of glycerin were found to be useless in suppressing molds, but helpful in retaining moisture in the wrapper.

LABORATORY INVESTIGATIONS.

Cigars on which mold had developed were obtained from several sources and submitted to examination. Two forms of mold seemed to be present—one, of most common occurrence, a small organism of grayish or whitish appearance, usually thinly scattered over the cigars, but most abundant and frequent at the head of the cigar, and the other a larger organism, occurring usually near the head of the cigar in rather sharply defined patches of a dazzling white color. The latter organism was much less frequently seen.

It being evident that the factories offered favorable conditions for retaining spores of molds when once introduced, it was clear that general treatment looking toward the eradication of these organisms was out of the question, assuming that it was practicable to prevent the entrance of new infections on tobacco leaf and other materials brought in. The most serious localized sources of trouble were therefore sought.

PASTE USED.

Gum tragacanth is used in small quantity to fasten the wrapper of the cigar in place. The wrapper is rolled tightly on the cigar, the rolling proceeding from the open end toward the head, the last portion of the wrapper remaining free being a small flap of leaf which serves to finish off the head. This small flap receives a little paste on the under surface and is then carefully brought into place. The cigar is then usually rolled with some pressure between the hand and the board or table at which the cigar maker works, thus giving it the desired regularity of form. Thus, a little paste is always found at the head of the cigar, and if an excess has been applied, especially if the paste is rather thin, a portion is liable to be squeezed out on to the board or table at which the maker works, and the cigars may receive a more or less extensive smear of paste over the surface of the wrapper.

The paste as usually made up contains about 10 parts by weight of gum tragacanth to 90 parts of water. A large stock is generally made in one container, sometimes only enough to last for the day and sometimes enough to last for a longer period. An inspection of the paste pots in several factories showed that while some were in fairly clean condition the sides of others were thoroughly covered with molds, indicating that in some cases little attention was paid to cleanliness regarding this feature.

An inspection of the wrapper leaf in no case showed visible mold, although it is a matter of common observation that when tobacco leaves are kept sufficiently moist in a closed space they can be made to mold.

MOLDS IN TRAGACANTH GUM.

Tragacanth gum is usually bought in considerable quantities for use in the larger factories, and, if the samples obtained in this investigation from several such sources were representative, the highest grades of the gum are not used. It was thought possible that these gums themselves might be carriers of molds, and several samples were set away in sterile Petri dishes to which a small quantity of sterile distilled water was added. These cultures, like others to be described, when not under observation were kept in a dark chamber in which the temperature varied between 21.5° and 25° C. In three days all the samples showed an abundant growth of molds, which began to develop fruiting stages on the fourth day. For further study, cultures were transferred to a medium containing one-half of 1 per cent sodium chlorid, 1 per cent peptone, 1 per cent beef broth, and +10 points acidity. Other cultures were also prepared on sterilized tragacanth gum, partly prepared on a thick paste and partly on a thinner paste.

Cultures on beef agar and peptone flourished and yielded a variety of organisms, which were turned over for identification to Mrs. Flora W. Patterson, Mycologist of the Bureau of Plant Industry. Four forms appeared with great regularity. Most conspicuous and quickest in growth were (1) *Rhizoporus nigricans* Ehren., a large organism forming large, loose, conspicuous hyphal masses; (2) *Mucor racemosus* Fres. var. *brunneus* Morini, a smaller organism rapidly forming a loose, white mass of hyphæ; and (3) *Penicillium* sp., a somewhat slower organism in point of development, marked by its white round-headed conidiophores. This organism in the early stages was striking by reason of its brilliant whiteness, but as the cultures grew older the more usual bluish color appeared. The last common form was (4) *Aspergillus candidus* Link, a very small mold, characterized by its slower growth, its dingy white color, and its appearance in mixed cultures as a minute undergrowth among the above-mentioned larger organisms. No attempt was made to carry out a further study of these organisms. It seemed clear, however, that the Aspergillus was more at home on the tragacanth medium than on the beef agar and peptone as here offered.

MOLDS ON WRAPPER LEAF.

As it seemed very probable that the wrapper leaves, like most other free surfaces, might give lodgment to spores of molds and thus become agents of infection, it was thought desirable to see what molds could be cultivated from them. Accordingly, cultures in the media previously described were prepared from the washings obtained by rinsing the surfaces of wrapper leaves with sterile water. Several organisms were obtained in small quantities, and Mrs. Pat-

terson identified the following: (1) *Aspergillus subgriseus* Pk., (2) *Macrosporium commune* Rabh., (3) *Sterigmatocystis castanea* Patters., (4) *Cladosporium herbarum* (P.) Link, (5) *Penicillium* sp. In general, the leaf surfaces were rather sterile of molds.

MOLDS ON CIGARS.

Samples of moldy cigars obtained from various sources were also investigated by the method described, and the following organisms were identified by Mrs. Patterson: (1) *Aspergillus candidus* Link, a very small dingy white mold, occurring as a rather sparse growth on cigars, especially near the head, but frequently in diffuse growth over a considerable part of the surface, which seems to be the most often present on cigars and is probably responsible for most of the trouble; (2) *Penicillium* sp., a widely distributed mold, likely to appear on a great variety of substances; (3) *Sterigmatocystis castanea* Patters., an unusual form, not likely to be a cause of harm here; (4) *Cladosporium herbarum* (P.) Link, one of the molds commonly turning up on decaying vegetable matter, probably not a source of serious trouble here.

It will be seen that the organisms responsible for the most serious trouble (*Aspergillus candidus*, easily first in importance, and *Penicillium glaucum*) are not represented in the list of organisms introduced on the wrapper leaf, but seem to be always present in the tragacanth gum. The conclusion seems, therefore, to follow that in the case in hand the paste used in fastening the wrapper at the head of the cigar brought with it the troublesome organisms.

INFECTION EXPERIMENTS ON WRAPPER LEAF.

It having been rendered probable that the tragacanth paste was inoculated with the molds from the start, the next question to be answered was that of the seat of the growth of molds on the wrappers. As it has already been shown that the paste itself is a favorable culture medium for these organisms, it follows that the tobacco leaf in itself is not necessarily a favorable support for the molds. However, it is well known that moist tobacco leaves do become moldy under conditions favoring this process, and experiments were made having for their object the infection of wrapper leaves with the two species of mold last mentioned. These attempts failed to produce mold on the leaves used in the absence of any substance foreign to the leaves that might act as a source of food for the fungi.

INFECTION EXPERIMENTS ON CIGARS.

In view of the nature of the problem under study, the fact that cigars could be infected with molds was not open to doubt. Since it had been shown that these molds do not readily grow on wrapper

leaf, it appeared probable, in view of the fact that the infection was introduced with the tragacanth paste, that the growth on the cigar was confined to the paste present on the wrapper. It was thought desirable to try to check up this conclusion by attempting to grow these molds on cigars. Accordingly, repeated attempts were made to grow the organisms in question on pieces of cigars moistened and placed in sterile Petri dishes or test tubes. In some cases these pieces molded and in others they did not. Usually the piece at the head of the cigar molded without difficulty, while those portions from other parts of the cigar molded less readily.

This seemed to confirm the view that the molds were introduced with and in general grew on the paste, and the appearance of the mold over a large part of the surface of a cigar indicated the smearing of excess paste over a corresponding portion of the surface.

REMEDIAL MEASURES.

Having located the cause of the trouble in the organisms above discussed and having found the point of their entrance, as well as the seat of their activities, to be in the tragacanth paste, practical remedial measures seemed to lie along the line of sterilizing the paste.

In view of the conditions governing the subsequent handling and final utilization of cigars, an acceptable sterilizing agency must combine several characteristics. It must be permanent, since cigars sterilized for but a short time are liable to mold at a later period when conditions of heat and moisture concur with or follow the exposure of the cigars to the infecting organisms. The substance must be odorless and tasteless; otherwise it will alter the taste and aroma of the cigar, points on which smokers, and therefore dealers, are very sensitive. It must not alter the color or the luster of the wrapper, since on these the selling quality of the cigars in considerable part depends.

STERILIZATION OF THE PASTE.

A variety of substances having antiseptic properties were chosen for test. In general they were dissolved in water, and the resulting solutions were either added to the paste already made or were used instead of water in making up the paste. These pastes were then inoculated with the molds obtained from the moldy cigars or from tragacanth gum.

A thin paste containing 10 grams of gum in 1 liter of water was first used. Hydroquinone, thymol, and sodium salicylate were introduced in concentrations as strong as could be used without influencing in an objectionable degree the taste, color, or odor. These pastes were then inoculated with *Aspergillus candidus* and *Penicillium glaucum*. In all cultures except that containing 5 c. c. of

a molecular solution of hydroquinone in 100 c. c. of paste, both molds appeared and throve.

A thicker paste, containing 10 grams of gum in 250 c. c. of distilled water, was made and a series of cultures prepared to which hydroquinone, thymol, and boric acid were added. Inoculation with the same molds followed. Hydroquinone in permissible concentration failed to suppress the organisms. Thymol in saturated solution, 1 c. c. and 3 c. c. per 100 c. c. of paste, suppressed them, but gave so marked an odor of thymol that the use of this substance was regarded as not advisable. Boric acid, 1 c. c. to 10 c. c. of saturated solution in 100 c. c. of paste, failed to suppress the organisms. Indeed, both grew more luxuriantly in these cultures than in the cultures containing simple paste. Cultures containing about 0.12 gram of dry boric acid in 100 c. c. of paste remained sterile.

In a third series of tests, solutions of the disinfectants were used instead of water in making the pastes. Solutions of hydroquinone and of boric acid were used in several proportions, as follows: For 1 gram of dry gum 25 c. c. of solution were used, consisting, respectively, of hydroquinone in molecular, one-half molecular, and one-fourth molecular concentration and boric acid in saturated solution at room temperature and in one-half saturated concentration. Since at 60° F. 1 part of boric acid dissolves in 26 parts by weight of water, it will be seen that the stronger boric-acid solution used instead of water in making the paste contained roughly 3.8 per cent of the acid. The paste cultures when made up were decidedly stiff and kept the form of small cakes in the Petri dishes. These cakes were inoculated with the two molds, and the cultures containing hydroquinone and the more concentrated boric-acid solution remained sterile. The culture containing the one-half normal boric-acid solution proved a more favorable medium for these molds than the plain paste.

It was rendered clear by these experiments that hydroquinone is effective when a solution containing 2.7 grams in 100 c. c. of solution is used instead of water in making the paste. Likewise, when a solution containing roughly 3.8 grams of boric acid in 100 c. c. of solution is similarly used molds are suppressed.

Tests of the adhesive quality of the pastes so prepared were made and it was conclusively shown that the presence of these chemical substances does not decrease the value of the paste in this particular.

After considering which of these substances should be recommended for general use, boric acid was chosen because it is cheaper, does not undergo change in the paste, is more readily obtained, and is not liable to injure anybody if used in excess. The disadvantages of hydroquinone lie in its contrasted properties on the points enumerated.

PRACTICAL DIRECTIONS FOR THE USE OF THE REMEDY.

A practical course of treatment based on the use of boric acid was accordingly outlined for tests on the factory basis. Since the paste evaporates water between the time of making and of using, a concentration somewhat less than saturation was recommended in making the paste. This would also tend to decrease the liability of the acid to crystallize out in a conspicuous way on the surface of the cigars should paste happen to be smeared on them. The following concise directions were prepared: Place boric acid in warm water at the rate of 1 ounce of dry acid to $1\frac{3}{4}$ pints of water. Stir till the acid is all dissolved. Use this solution instead of water in making up the paste. Great care should be taken not to use more paste on the cigar than is necessary, since it is liable to be smeared on the surface of the cigar, where the boric acid in the paste tends to crystallize, giving an appearance suggesting mold.

These directions have been followed for some years in the factory in which the complaints originated, and when the writer was last in communication with those in charge the boric-acid treatment was in use as a routine practice and only in rare instances were molds found troublesome.

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